

Modeling Jihad: A System Dynamics Model of the Salafist Group for Preaching and Combat Financial Subsystem

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Introduction

This paper will describe the authors' efforts to model the financial operations and organizational behavior of the Salafist Group for Preaching and Combat (known by its French initials, GSPC), using Stella® version 9.0, a commercially-available system dynamics software package. The model aggregates empirical knowledge and collective expert opinion on the GSPC financial subsystem into a single cognitive tool.[1] Using the model for exploratory analysis suggests answers to questions such as how funding affects the quantity and type of GSPC operations, how the financial and operational aspects of the organization change over its life cycle, and what policymakers should expect next from the GSPC. Finally, the model allows users to see the full range of effects from different policy choices, including effects policymakers may not intend.

Complex systems defy analysis through normal cognitive methods. As such, modeling is an ideal heuristic to further understanding of these systems.[2] Unfortunately, prior modeling of terrorist organizations is limited. Joshua M. Epstein, John D. Steinbruner, and Miles T. Parker from the Center on Social and Economic Dynamics previously built a model of civil violence utilizing an agent-based approach.[3] The systems dynamics approach to terrorism evolved from work done by the RAND Corporation on deterring and influencing al Qaeda.[4] Building on the RAND Corporation's efforts, Air Force officers Troy Thomas, Steven D. Kiser, and William D. Casebeer developed a methodology for analyzing violent non-state actors (VNSA) based on open-systems theory.[5] Casebeer and Thomas later collaborated with Jason Bartolomei to apply their methodology to Peru's Sendero Luminoso, developing a system dynamics model of Sendero's recruitment sub-system.[6] Prior modeling specific to terrorist financing is virtually non-existent. The notable exception is Steve Kiser, who used a linear programming methodology to model al Qaeda's financial support structure.[7]

The GSPC Financial Subsystem

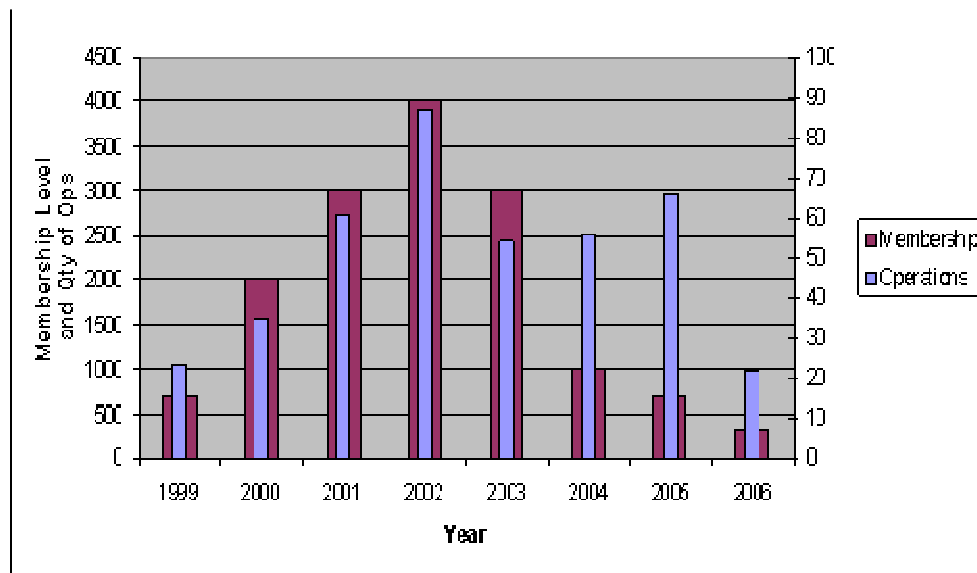
The GSPC financial subsystem consists of a series of funding streams into and out of the organization. Incoming funding includes revenues generated from extortions, donations, smuggling, business fronts, kidnappings, and external support. Outgoing funds pay for overhead costs and operational expenses. Complicating efforts to model the GPSC financial subsystem

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was the requirement to replicate its functions in both North Africa and Europe. Although the group historically confined its operations to Algeria, today it appears to be expanding throughout North Africa.[8] Additionally, the GSPC has reportedly “taken over the GIA’s external networks across Europe.”[9] In September 2003, the group’s leader declared allegiance to al Qaeda.[10]

Notably, GSPC operations show little correlation to the group’s membership numbers. After Hassan Hattab led a group of around seven-hundred Islamists out of the Armed Islamic Group (GIA) to form the GSPC sometime between 1996 and 1998,[11] the organization rapidly grew in strength. By 2002, it had approximately four thousand members.[12] Since then, however, GSPC membership has declined to somewhere between three-hundred and five-hundred fighters.[13] Despite this drastic decline in membership, the GSPC’s violent activity shows no signs of letting up. [Figure 1](#) charts the GSPC’s estimated strength and quantity of operations by year, revealing that 2005 was the second most active year in the organization’s history despite a massive drop in membership numbers.

Figure 1: GSPC Membership vs. Quantity of Operations



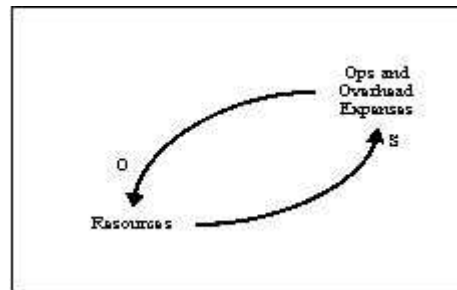
Although counterintuitive, the lack of correlation between membership and operations comports with existing theories of guerrilla warfare.[14] This simplified the model of the GSPC financial subsystem, allowing it to discount organizational membership and focus exclusively on resources and operations. The model uses a political economy framework to link these two organizational facets. Since terrorist “funding sources can shape the behavior of terrorist groups,”[15] this framework can illuminate not only how the financial subsystem reacts to its environment, but also how it affects the output of the GSPC’s operations.

Subsystem Causality

To better understand the interactions within this highly complex subsystem, the authors built a series of causal loop diagrams depicting resource inflows, resource outflows, and European operations. [Figure 2](#) shows the basic causal loop for the GSPC financial subsystem, the “resources-operations” loop, using standard systems dynamics conventions. Arrows between two variables indicate a causal relationship. The “s” or “o” next to each arrowhead denotes whether the connected variables move in the same or opposite directions. Thus, the diagram in [Figure 2](#) denotes that an increase in GSPC resources leads to an increase in overhead and operations

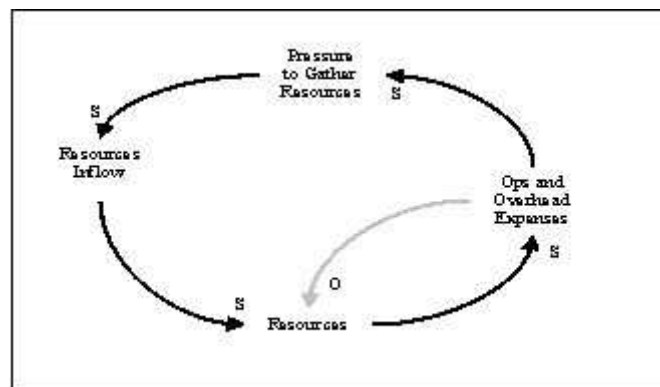
expenses. Conversely, increased overhead and operational expenses decrease the GSPC's overall resources.

Figure 2: Resources-Operations Loop



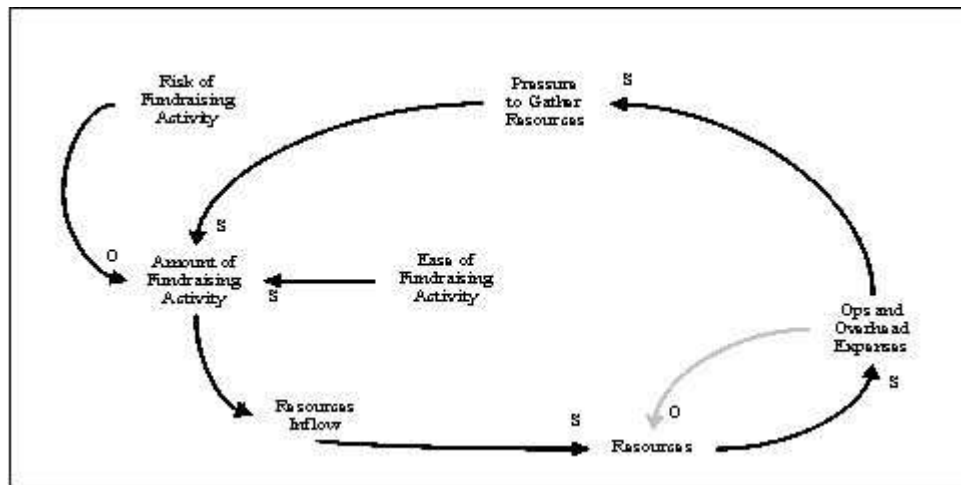
While the causal loop in [Figure 2](#) shows the basic relationship between the GSPC resource pool and its expenses, it neglects how the organization replenishes its resources. Accordingly, [Figure 3](#) adds a basic resource inflow process to the resources-operations causal loop. As resources are expended through overhead and operations, this increases the pressure on the organization to gather more resources. As this pressure increases, the group seeks out ways to gather resources and input them into their overall resources base.

Figure 3: Resources-Operations & Resource Inflow Loops



[Figure 4](#) expands on the resource inflow loop shown in [Figure 3](#), illustrating the fundraising process in greater detail. Whereas the [Figure 3](#) causal loop showed a direct cause and effect between the pressure to gather resources and the resource inflow, [Figure 4](#) more accurately shows that the amount of fundraising activity an organization undertakes intervenes in this relationship. In GSPC's case, the organization chooses between six basic fundraising activities: popular extortion, popular donations, crime, legitimate businesses, high dollar kidnappings and ransom, and external support (e.g., from a state or non-governmental sponsor). Economic theory indicates that the GSPC will consider the costs of each of these activities when deciding which one to undertake.^[16] In the model, these costs are represented by variables for risk and ease. Risk represents the terrorists' perception of their chances of getting caught during a particular fundraising activity. Ease indicates where each activity ranks on a scale of difficulty.

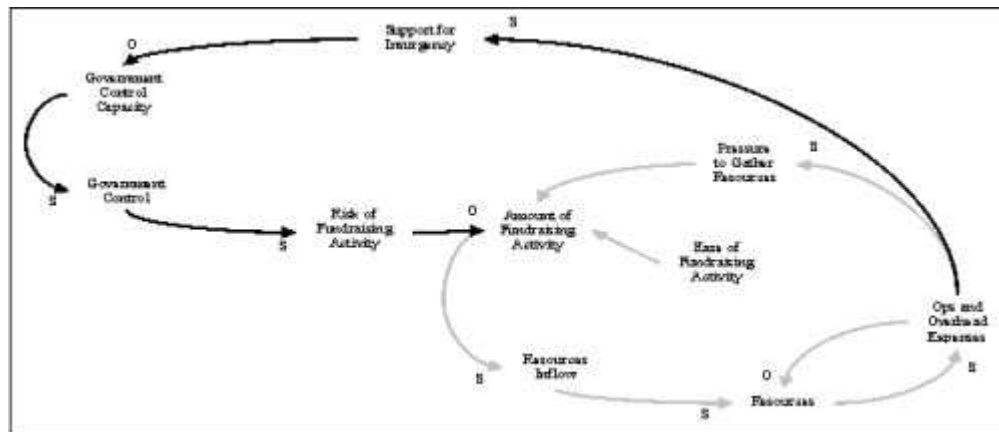
Figure 4: Generic Fundraising Loop



The model treats the ease of each fundraising activity as exogenous to the system. In general, the level of effort required to extort, solicit donations, run a business, kidnap, or garner external support does not change in Algeria over the life of the GSPC. The same is not true for risk. Literature relating to the economics of crime and terrorism informed the authors' modeling of these relationships. In a 1978 study on aircraft hijackings, William Landes showed that the number of U.S. hijackings dropped precipitously after the installation of airport metal detectors because they increased the risk of capture facing potential hijackers.^[17] Thus, governmental policies intended to stymie terrorist operations affected the terrorists' perceived risk. In the GSPC financial subsystem model, if the terrorists elect to proceed with a given activity despite the risk, they are rewarded with a 100 percent success rate. Thus, in the model risk actually represents the deterrent effect of government policies versus any substantive benefit such as capturing or killing terrorists.

In the GSPC financial model, the level of government control represents what other economists have called "the government's allocation of resources to thwart various acts of terrorism."^[18] Since high levels of insurgent support decrease the number of government collaborators and informants among the populace, the amount of government control at any particular time is a function of support for the insurgency. Without collaborators and informants, the government finds itself unable to strike out at the insurgents who, like Mao's fish in the sea, disappear into the local population. In the model, this is represented by a support for insurgency factor, a non-dimensional variable which affects the government's ability to impose its will. Finally, since insurgencies generally enjoy increased support from the people as operations against the government increase, the model also accounts for this relationship, as illustrated in [Figure 5](#), the Insurgent Support Loop.

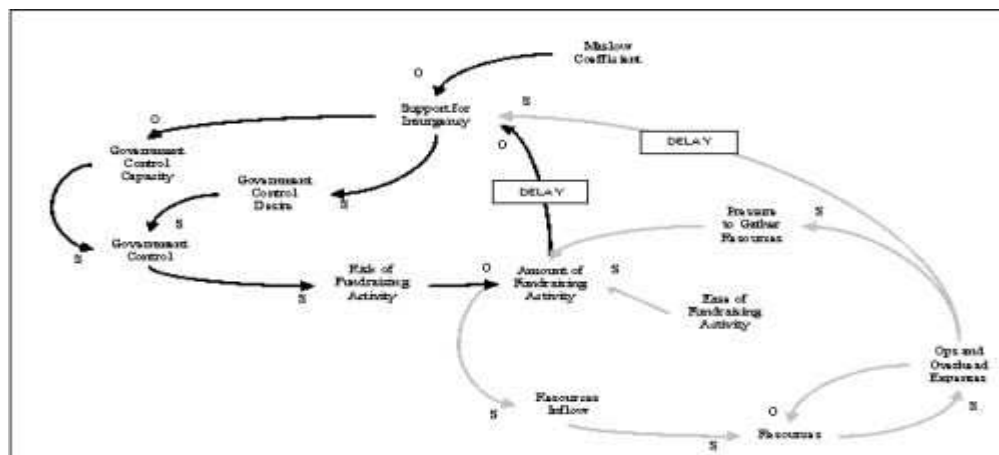
Figure 5: Insurgent Support Loop



The loop in [Figure 5](#) neglects several dynamics affecting insurgent support and government control. Accordingly, [Figure 6](#) expands the causal loop diagram to illustrate several feedback loops within the GSPC's insurgent support system. Note that as support for insurgency increases, the government's desire to quell the insurgency grows. For the sake of simplicity and to aid in policy options analysis, however, the authors modeled governmental desire to control the insurgency as a direct user input.

[Figure 6](#) also indicates that while the support for insurgency changes over time as a function of insurgent success (the proxy for which is the GSPC's number of operations against the Algerian government), the impact of this success is delayed. Furthermore, certain types of fundraising activities negatively influence the level of popular support for the insurgency. For example, as the GSPC increases the number of extortions it carries out against the Algerian population, this decreases the population's support for insurgency. This negative effect is also subject to a delay. These two delays are not equal, however. Based on previous study of insurgency and preferences,[19] the model incorporates a slower increase in support from successful GSPC operations and a more rapid decrease in support from extortions. This assumption also holds intuitively, as it takes a significant amount of time for an organization to build loyalty among a population, but it can squander that social capital rapidly if taken for granted.

Figure 6: Insurgent Support Feedback Loops and Maslow Coefficient



In addition to these delayed feedback loops, support for insurgency is also a function of various social and economic conditions in Algeria. Throughout the 1990s Algeria suffered from a host of socioeconomic problems. These included high unemployment, eroding infrastructure, government corruption, and inadequate housing, health care, and education.[20] For example, even though Algerian unemployment has declined recently as a result of high oil prices, the unemployment rate remains at 22.5 percent. In 2005, a United Nations Human Development Report ranked Algeria 103 out of 177 countries for health, education, and standard of living.[21]

To model the relationship between these socioeconomic conditions and support for the insurgency, the authors relied on earlier system dynamics techniques used to model Sendero Luminoso.[22] These efforts measured popular disaffection as a combination of economic, quality of life, social, and moral stocks and flows.[23] For simplicity, the authors aggregated these variables into a single Maslow coefficient. A higher Maslow coefficient equates to an overall higher level of satisfaction with life among the Algerian population. Thus, increases in the Maslow coefficient decrease the willingness of the population to support the insurgency.

Subsystem Stocks, Inflows, and Outflows

To determine the precise relationships between variables for each aspect of the GSPC financial subsystem these relationships, the authors relied extensively on evidence of GSPC fundraising and operations from open-source reporting. Foreign Broadcast Information Service (FBIS) reports translated from the Algerian media proved especially useful in this regard.

Resource Stock

In the model, resources flow into the GSPC's resource pool from a theoretically endless supply as a result of the group's fundraising activity. To set the initial GSPC resources level, the authors considered evidence that the GSPC received seed money from al Qaeda. According to Rohan Gunaratna, bin Laden did not approve of the Armed Islamic Group's (GIA) widespread massacring of civilians in Algeria. Accordingly, the Qaeda leader "severed all ties with the GIA leadership, denounced [GIA leader] Antar Zouabri, and encouraged Hassan Hattab to break away and join the GSPC." [24] Al Qaeda and the GSPC then entered a mutually beneficial financial, logistical, and operational relationship.[25] While the precise amount of seed money al Qaeda provided the GSPC is unavailable, another al Qaeda affiliate, Ansar al Islam, received between \$300,000 and \$600,000 in September 2001.[26] Since al Qaeda was in a similar financial situation from the end of the 1990s until the U.S. invasion of Afghanistan, the authors assumed a similar amount of seed money would have gone to Hassan Hattab to set up the GSPC. Thus, the model contains an initial resource value of \$300,000 for the GSPC.

Popular Extortion

The GSPC relies extensively on extortion of Algerian nationals to finance its activities. Two types of extortions exist. First, the GSPC shakes down groups of people either in their villages or by setting up illegal roadblocks. Typical of a GSPC shakedown was a May 2006 GSPC raid on a café in the town of Ouled Rabah. "Once surrounded, the customers were forced to listen to a bloodthirsty sermon" before the terrorists "ordered the targeted people to pay them major sums of money." [27] Similarly, on 22 October 2004, the GSPC ambushed a busload of soccer fans south of Algiers.[28] To determine the value of these attacks to the GSPC, the research authors considered several factors including Algerian capita gross domestic product (GDP) and cost of living. With a per capita GDP of just over \$2000 per year,[29] most members of the Algerian population spend their monthly income almost immediately in order to subsist. Because few Algerians have the opportunity to accumulate wealth, members of the population likely would have only around one month's income (between \$100 and \$250) on hand at any given time for the GSPC to extort. Since the GSPC normally targets between twenty and fifty people during

each of these attacks, the model determines the earnings from each of these extortions stochastically across a normal distribution with a mean of \$5000.

A second type of extortion is GSPC kidnapping of wealthier members of society. For example, the group recently kidnapped “the son of an entrepreneur” near the town of Boumerdes. As the Algerian press caustically noted, “[t]his kidnapping is not anything alien to the groups from the Salafi Group for Call and Combat, which are in the habit of abducting entrepreneurs, businessmen, and even their relatives to demand ransoms in exchange for their release.”^[30] Once again, GDP helps determine the value of these attacks to the GSPC. In Algeria, the richest 20 percent of the population control 42.6 percent of the wealth.^[31] The average per capita GDP for this elite group is just under \$5000 per year. Since this seemed to be a reasonable amount for a ransom demand, the model once again stochastically determines the earnings from kidnapping extortion across a normal distribution with a mean of \$5000.

Popular Donations

While the GSPC forces some Algerians to finance its activities through extortion, a number of people voluntarily give their support to the organization. The Algerian press consistently reports arrests of individuals for their support of the GSPC. In May 2006, for example, “[a]bout 10 people involved in the support activities for the GSPC’s armed groups were arrested by soldiers in several areas east of Boumerdes.”^[32] Also in May 2006, authorities disrupted a “network [that] reportedly supplied intelligence and food” to the GSPC in the El-Aouana region.”^[33] According to the Algerian press, the government has broken up more than thirty such support networks comprised of over two hundred people in the Boumerdes region alone over the past two years.^[34]

The amount of money the GSPC receives from the Algerian population is a function of the capacity and desire of people to donate to the cause. Wealthy Algerians have the most to lose should the GSPC successfully overthrow the Algerian government. Therefore, they are unlikely sources of voluntary revenue. Furthermore, empirical data indicates most GSPC collaborators support the organization by providing food and shelter. These are relatively inexpensive commodities compared to weaponry and ammunition. This suggests popular support from the GSPC comes from the poorer segments of the population.

In the GSPC financing model, revenue from domestic donations is a function of the capacity of the poorest 20 percent of the population to donate to the cause. The 6.38 million Algerians in this bracket control only 7 percent of the nation’s wealth.^[35] After considering cost of living data, the authors concluded that there is little Algerian domestic capacity for making donations to the GSPC. Lacking significant amounts of disposable income, those who do support the insurgency tend to provide food and shelter rather than large monetary donations. To depict this, the model constrains the quarterly donation value to a maximum of \$100,000. This equates to a donation of between one and two cents per quarter from each person in the poorest 20 percent of the population.

Of course, not all of the 6.38 million poorest people in Algeria will donate to the insurgency each quarter. Indeed, the number of people willing to donate to the GSPC is a function of the support for insurgency factor. Support for the insurgency, in turn, is a function of the Maslow coefficient, the success of the insurgency, and its exploitation of the population. As these factors converge to raise support for the insurgency, the amount of resources the GSPC will receive from popular donations also rises. Conversely, if support for the insurgency decreases, popular donations to the GSPC also decrease. To determine the nature of this relationship, the authors turned to a RAND Corporation study of insurgent conflict written near the end of the Vietnam War. According to the study, the curve representing support for the insurgency “is likely to be ‘kinked’ at both high and low [support] levels (because of a shortage of wholly committed, ardent supports at high levels, and the ‘bandwagon’ effect at low levels).”^[36] Accordingly, the authors modeled the domestic donation input to the GSPC as an exponential curve with two “kinks.” The exponential

shape of the curve accounts for the bandwagon effect. The two “kinks” reflect that no matter how high the support for the insurgency reaches, some holdouts will continue to support the old regime. Similarly, even if the support for insurgency factor reached zero, population donations remain present at a low level, representing the reticence and devotion of the GSPC’s hard-core support base.

Smuggling

The Algerian GSPC is closely tied to smuggling operations in the Sahel. The main commodity trafficking through the Sahara is in cigarettes, “what the Algerians call the Marlborough Connection.”^[37] According to media reports, U.S. intelligence believes GSPC operations in the region are under the command of Mokhtar Benmokhtar. The organization does not actually engage in smuggling, however. Instead, “the GSPC has made an agreement with drug dealers and tobacco smugglers. The latter give money and fuel to the GSPC, which, in return, guarantees a right of passage, and even recommend[s] ways [for] them to escape from the region’s customs services and security forces.”^[38] Other reports indicate that some smugglers share their merchandise with Benmokhtar in order to buy his protection.^[39] Reportedly, the GSPC uses proceeds from cigarette trafficking to purchase weapons from Mali and Niger. These activities generally escape detection by authorities since the population of the region is less likely to report smuggling than terrorism.^[40]

No firm numbers on the extent of cigarette smuggling in the Sahel region are publicly available. Fortunately, it is possible to infer the extent of smuggling through other data. According to the World Bank, in 1994, Algerian cigarette consumption totaled over 16.8 billion cigarettes. The 1997 cost for twenty cigarettes was between 100 and 140 Dinar, or \$1.86 and \$2.38.^[41] Combining these two statistics yields a total value for the Algerian cigarette trade approaching \$1.6 billion. Research has shown a loose correlation between the amount of cigarette smuggling in a country and Transparency International’s corruption perceptions index.^[42] Algeria’s transparency index is 2.8,^[43] which suggests approximately 17 percent of the total cigarette industry is dependent on smuggled goods.^[44] This equates to approximately \$275 million dollars of cigarette smuggling per year.

It is highly improbable that the GSPC is able to tax the totality of the Sahel based “Marlboro connection.” The Sahel is a vast and expansive desert region. The Algerian government has difficulty establishing control over this area even with all the resources of the nation-state. The GSPC, with its limited membership, certainly has much less capacity to do so. Accordingly, the model assumes GSPC is only able to tax 10 percent of this smuggling operation per year. This yields \$2.75 million dollars worth of smuggling available for exploitation by the GSPC each year.

Unfortunately for the GSPC, Belmokhtar is widely seen as an individual now motivated more by money than ideology. As one expert noted, he “no longer [has] anything to do with a political project, it is almost a way of life; it is basically criminal banditry.”^[45] To account for Belmokhtar’s pecuniary motivations, the authors modeled a 30 percent skimming factor. While this factor is comparable to skimming reported from GSPC fundraising operations in Europe,^[46] the authors suspect it is conservative with respect to the rapacious Belmokhtar.

Business Fronts

GSPC operatives are suspected of running several legitimate businesses in Algeria. Although one report suggests the GSPC uses a travel agency as a business,^[47] open-source reporting has limited details on this GSPC financing stream. Despite this dearth of unclassified data, most terrorist organizations do use business fronts to increase their resource base. Legitimate business operations are attractive because of their low risk and reasonable potential returns.^[48] The model reflects this characterization of legitimate business by assigning a lower risk and

greater ease for terrorists to engage in this financing activity compared to other fundraising methods.

High Dollar Kidnappings and Ransoms

High dollar kidnappings and ransoms are a significant source of revenue for the GSPC. While the model's extortion module accounts for some kidnappings, it does not include high dollar ransoms paid by the extremely wealthy due to several qualitative differences. First, the amount of ransom is orders of magnitude above those paid by the normal populace, ranging from one-hundred thousand dollars into the millions. Second, high dollar kidnappings are few and far between. Indeed, only three high dollar kidnappings and ransoms have been reported. In February 2003, a GSPC group operating in southern Algeria kidnapped thirty-two European tourists. The GSPC only released the hostages after Germany paid a reported six million dollar ransom to the group.[49] The other two have occurred more recently. In April 2006, the GSPC kidnapped an entrepreneur in Boumerdes, reportedly demanding "eight hundred million centimes [approximately \$100 thousand] for his release." [50] In May 2006, the GSPC released the brother of the Haddad Company's chief executive officer. His abductors "had demanded 250 million dinars [approximately \$3.4 million] in exchange for his release." [51]

As a one time event, the GSPC's kidnapping of European tourists appears to be an operation of opportunity. A GSPC defector claimed that the "decision to kidnap [the European tourists] was made spontaneously" during a routine extortion roadblock.[52] Initially, the GSPC let the tourists pass, intending only to follow them to their base camp in order to steal their Toyota vehicles. Only the next morning, after finding the tourists had only one Toyota and several motorcycles, did the GSPC decide to ransom the tourists.[53] The two more recent attacks on wealthy Algerians may be part of a larger trend, but the data is inconclusive. Therefore, the model includes a high dollar kidnapping function which the user can enable or disable at different times during the simulation in order to replicate the opportunistic nature of these events.

External Support

Although the Algerian government has accused Iran and Sudan of supporting the GSPC,[54] there is little evidence that the GSPC is receiving any external aid from either state or non-state actors. As mentioned above, sources suspect the GSPC did receive seed money from al Qaeda, but continuing support is unlikely given the U.S. attacks on Afghanistan and subsequent disruption of bin Laden's network. More recently, reports surfaced of the GSPC asking for assistance from al Qaeda in Iraq (AQI). An alleged letter from the GSPC to AQI reportedly "pleaded for the help of al-Qaida's chief in Iraq, [the late] Abu Musab al-Zarqawi, following painful setbacks." [55] The letter asked Zarqawi to "support brothers in Algerian jihad groups by making sermons that call for defeating the tyrants." [56] AQI is the current beneficiary of significant sums of money flowing from Saudi Arabia.[57] As such, the organization probably could afford to provide financial assistance to outside groups. Additionally, AQI has two possible motives for assisting the GSPC. First, the GSPC reportedly supports insurgent operations in Iraq by providing Algerian suicide bombers.[58] Second, AQI is currently engaged in a power struggle with Afghanistan-based al Qaeda elements.[59] Notably, the GSPC vehemently denies having sent this letter to Zarqawi.[60]

Nonetheless, there is no evidence AQI has redirected any of that money to Algeria. Therefore, the authors concluded GSPC was not currently receiving significant external support. However, in order to assist with later analysis, the authors did include provisions for external support in the model. This functionality is disabled in the base model, and the flow of external support to the GSPC is set at zero.

Resource Outflows

Terrorists must make basic economic decisions with respect to resource allocation. While a traditional business markets goods and services in order to meet a profit objective, terrorism creates a peculiar commodity (terror or fear) in pursuit of a political objective.[61] In producing their commodity, terrorists incur two sets of costs. The first of these is overhead. Typical terrorist organization overhead costs equate to somewhere between 70 and 80 percent of their total budget.[62] The authors elected to model the GSPC at the efficient end of this spectrum and set overhead expenses at 70 percent of the GSPC's budget.

The second outflow of GSPC resources derives from operational costs. In 2002 a member of Hezbollah "put the figure of a terror attack at \$665-\$1,105." [63] Hezbollah operations range from simple shootings to bombings, the latter being somewhat more expensive than the former. Since the GSPC conducts many more ambushes and assassinations than bombings, its cost per operation is likely to be at the low end of the Hezbollah estimate. Thus, the model determines the cost per Algerian operation stochastically across a normal distribution with a mean of \$700.

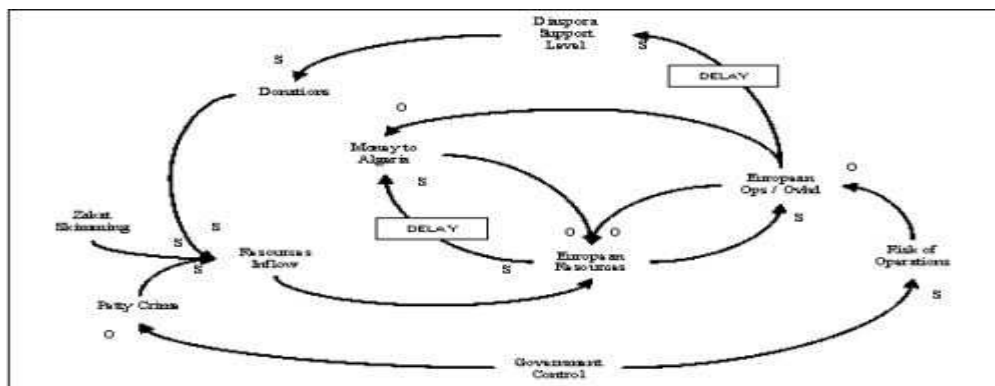
European Fundraising and Operations

The operational scope of the GSPC extends beyond the borders of Algeria. Evidence suggests the GSPC has formed cells in France, Italy, Spain, and Britain.[64] Indeed, by 2000 the GSPC had displaced the GIA throughout the Algerian Diaspora in Europe.[65] Since that time, authorities have arrested numerous terrorist operatives and disrupted several GSPC terrorist cells across Europe.[66] Most recently, Swiss police arrested seven suspected GSPC members allegedly plotting an attack on an El Al Airliner.[67]

Three sources comprise the bulk of GSPC's European fundraising. First, Mohamed Sifaoui, an Algerian-born French journalist, infiltrated a GSPC fundraising cell that skimmed zakat donations to fund terrorist operations.[68] Second, disenfranchised Algerian youth engage in petty crime, including "car theft, credit-card fraud, and document forgery; and their earnings [are] channeled to finance terrorist activity." [69] Finally, an unknown amount of money is knowingly donated to the GSPC.[70]

As depicted in [Figure 7](#), the authors modeled European GSPC finances and operations using logic similar to that applied to the organization's Algerian operations. European resource inflows include skimming from zakat contributions, petty crime, and voluntary donations. Since Sifaoui witnessed skimming during his infiltration of the GSPC, the amount reaped from zakat is reduced by 30 percent.[71] European resource outflows include cell sustainment and terrorist operations costs. Cell sustainment is the first priority, and money that is leftover is used for terrorist operations in Europe.[72] Excess money is then funneled to support the GSPC's Algerian insurgency.[73]

Figure 7: European Operations



Modeling Results

Producing a working system dynamics model is only the first of many steps in the modeling process. A robust validation and verification is required to assess the model's fidelity. Furthermore, sensitivity analysis helps reveal the usefulness of the model for performing policy options analysis. Whether accurate or not, models that are overly sensitive to changes in initial-conditions or relationships between variables have limited utility. Following a robust validation, verification, and sensitivity analysis, policymakers know the full range of a model's strengths and weaknesses and can use the model to help them assess various courses of action.

Validation and Verification

To facilitate validation and verification, the authors ran the GSPC financial subsystem simulation twenty times under baseline conditions. Each run examined the eleven year period from 1999 to 2010. Overall, behavior of the GSPC financial subsystem model seems to comport with reality. Simulation results suggested the GSPC receives most of its income from smuggling, followed by extortions, donations, and business fronts. These results match available empirical data. Similarly, the model appears to accurately portray GSPC strength over time, extortion activity, Algerian and European operations tempo, and high dollar kidnappings.

GSPC Strength over Time

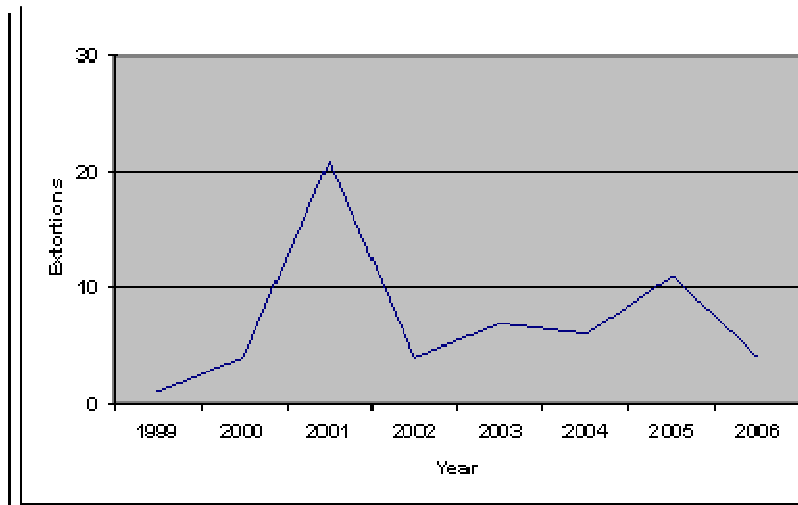
Simulation results showed an overall decline in GSPC strength over time, as measured by the level of support for the group among the Algerian population. This decline of popular support for the GSPC appears to mirror reality. Unfortunately, no quantitative data on the Algerian population's support for the insurgency is available. However, according to Professor William B. Quandt of the University of Virginia, Islamists currently enjoy the support of around 20 percent of the Algerian population. Furthermore, support for Islamist terrorism has been in steady decline since the late 1990s.^[74] Other experts confirm that the current state of popular support for the GSPC is low, although quantifying the level of support remains difficult.^[75]

As expected, once the GSPC exhausted its initial seed money and started extorting, support for the organization dropped. Interestingly, after support dropped during simulation, the GSPC decreased its extortion activity and focused instead on operations against the Algerian government. This action should have bolstered support for the insurgency among the populace. However, the degree to which the GSPC decreased its extortion activity during simulation never reached the point where it reversed the overall decline in popular support over time.

Extortions

Data on the GSPC's extortion activity tracks closely to the results from simulation, as seen in [Figure 8](#). For example, in 1999, the GSPC executed few extortions of the populace, but the number spikes to over twenty in 2001. Subsequently, the number of extortions drops again in 2002. This pattern is repeated over the next few years. Extortions increase slightly in 2003, followed by a decrease in 2004 and a spike of just over ten extortions in 2005. During simulation, the number of GSPC extortions exhibited similar behavior, spiking and declining during alternate years. However, the model's extortions input comes from spikes of over thirty extortions per year. This is a significantly higher frequency than the number reported in the open press. Although this discrepancy could be a consequence of an inaccurate assumption in the model (e.g., a pessimistic earnings per extortion), it might also result from inaccuracies in the validation database. Truth data on the number of extortions is derived from FBIS open source reporting. Accordingly, the discrepancy between reported and simulated extortions could indicate an under-reporting of extortions in the open press. This scenario seems plausible, given that many of the GSPC's extortions are of the relatively poor in rural parts of Algeria.

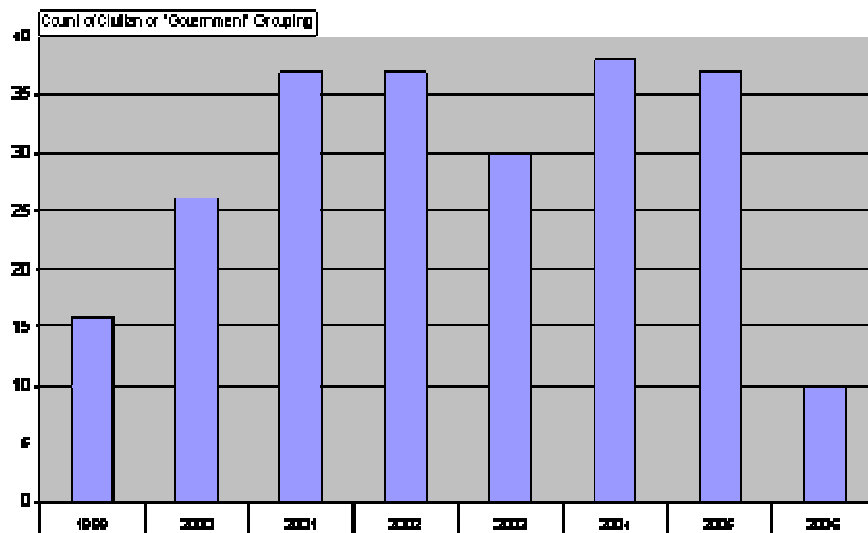
Figure 8: Extortions per Year



Algerian Operations

The number of GSPC operations against the Algerian government is close to the output from the simulation. As shown in [Figure 9](#), data from open sources indicates a median attack frequency of just over thirty-five per year. The simulation produced similar results, with a median attack frequency between 8 and 12 attacks per quarter, depending on the run. One notable discrepancy exists between simulation and real-world data, however. The model predicts a higher number of attacks per year, steadily declining, for the first three years of GSPC operations. In the model, this is a result of the organization using the “seed money” allocated to them from al Qaeda to fund operations during the first year. In contrast, real-world data indicate a steadily increasing number of attacks between 1999 and 2001. As before, this discrepancy might be the result of inaccurate reporting. A known bias in the open press is that it attributed several GSPC attacks to the GIA prior to the former organization gaining notoriety. An alternative but less likely hypothesis is that the existence or amount of the \$300,000 al Qaeda seed money in the model could be inaccurate.

Figure 9: Total Attacks of Government Targets



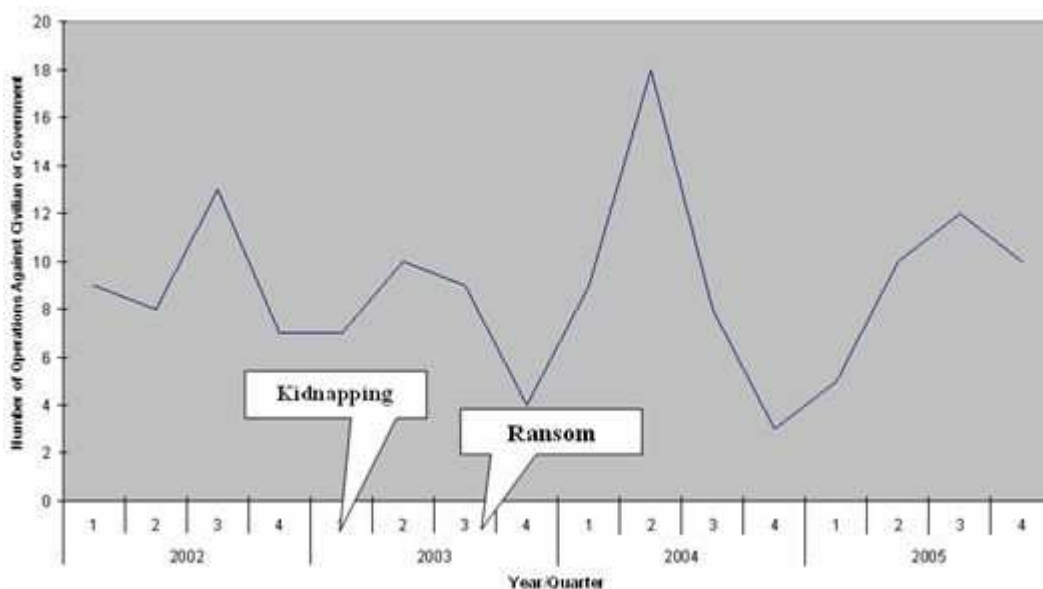
European Operations

The model's simulated results for European operations are consistent with observed patterns. Unfortunately, however, data for a full validation and verification are not available. Simulation resulted in the GSPC conducting an average of 1.75 attacks in Europe per year, or seven attacks every four years. This is consistent with the eight reported GSPC-planned attacks in Europe from 1999 to 2006.^[76] Additionally, the model suggested the amount of money flowing from Europe to Algeria is approximately \$37,000 per quarter, or \$148,000 per year. Regrettably, no data on the precise flow of GSPC funds from Europe to Algeria is available to validate and verify these results. Still, simulation results qualitatively match the aggregate of expert opinion, which suggests most money raised in Europe is spent in Europe and very little is sent to Algeria to support the insurgency.

High Dollar Kidnappings

When the model's high dollar kidnapping functionality was enabled, the simulated GSPC would perform one of these attacks relatively infrequently, with the timing of the event determined stochastically against a target of opportunity. Analysis of simulation results indicates that following a high dollar kidnapping authorities can expect a significant increase in operations against the Algerian government. During simulation, the spike in Algerian operations was proportional to the amount of money received from the kidnapping. Additionally, simulation showed a temporary three quarter lull in GSPC extortion activity. Truth data on operations against the Algerian government are shown in [Figure 10](#). As mentioned above, in February 2003 the GSPC captured 32 European tourists in the Sahel. Reportedly, the German government paid a 5.5 million Euro ransom in August 2003.^[77] Although there is an increase in the number of operations against the Algerian government following the ransom payment, the intensity of the increase during simulation was much greater. Whereas truth data indicated operations against the government spiked to just under 20 per quarter, simulation suggest the number would be closer to fifty such attacks.

Figure 10: Quarterly Operations against the Algerian Government



The authors investigated two hypotheses to explain this discrepancy. The first hypothesis was that the real-world operations did not increase at the same rate as in the model because the real

world the kidnappers took an extensive cut of the profit. The available evidence disproves this hypothesis. A GSPC defector reported that Abderrazek al Para, the GSPC Emir from zone 5 responsible for the kidnapping, paid his men a paltry bonus of only 300 Euros each.[78] The second hypothesis was that the GSPC invested a portion of the windfall from the kidnapping into infrastructure or supplies rather than spending it immediately on operations. The evidence confirms this is indeed what happened. Defector reporting indicates that al Para disbursed the ransom money to four separate groups, tasking each to purchase weapons and ammunition in Mali and Niger.[79] The model does not allow for such sophisticated investment patterns.

Sensitivity Analysis

In system dynamics modeling, once one appears to have a valid model the next step is to subject it to a robust sensitivity analysis. The goal of this sensitivity analysis is to determine to what extent the model's apparently valid behavior depends on assumptions made during its construction.[80] In the case of the GSPC financial subsystem model, changes to most parameters resulted in predictable and insignificant changes to simulation outcomes. Results from the sensitivity analysis on the amount of zakat available for skimming in Europe are representative. As the authors increased the GSPC's ability to skim from zakat, European operations and the flow of money from Europe to Algeria increased proportionally. Nonetheless, changes to other parameters, including initial seed money, popular ability to donate to the insurgency, the level of initial support for the insurgency, and the overhead cost factor yielded interesting results worthy of more detailed discussion.

Initial Seed Money

Changing the GSPC's initial seed money significantly affected the life-cycle of the terrorist organization during simulation. When the GSPC received less seed money, this caused the organization to resort to extortions to raise money sooner, which subsequently decreased their popular support level and hastened their eventual demise. Conversely, when the GSPC received more seed money, the organization would delay its resort to extortion, thereby extending its life span by several years. A high level of seed money allowed the group to focus its efforts on operations against the government. When the GSPC's initial seed money was set at \$1 million, the organization's level of popular support actually increased slightly over the first three years of its life. Once the GSPC's declining resources forced it to resort to extortion, however, public support began a slow decline.

Overhead Costs

Lowering the percentage of resources devoted to overhead costs in the model (i.e., increasing terrorist efficiency) resulted in a significant increase in the terrorist organization's probability of success. Since the GSPC required fewer resources for overhead expenses, it could devote more of its attention to operations against the government. Reducing overhead costs from 80 percent to 50 percent of expenditures resulted in an increased pace of operations against the government. This increased operations tempo decreased the rate of decline in popular support for the insurgency, but it did not reverse this decline. The organization simply lived longer.

Popular Ability to Donate to the Insurgency

Changing the ability of the population to donate to the insurgency revealed an interesting effect. Although decreases to the popular ability to donate forced the GSPC to resort to extorting the population slightly earlier, this did not significantly reduce the GSPC life-cycle. On the other hand, increasing the population's ability to donate in the simulation had significant benefits for the GSPC. Increasing popular donation capability from \$100 thousand per quarter to \$1 million

significantly delays the GSPC's demise. If the popular donation capability is raised high enough (e.g., by another order of magnitude), the GSPC actually increases in strength over time.

This result has significant policy implications for the Algerian government. Foremost, it indicates that improving the economic conditions of the poorest in Algerian society has the *potential* also to improve the GSPC's economic conditions. This contradicts the notion that improved economic conditions can, by itself, starve an insurgency of support. Instead, analysis suggests the Algerian government will only see its position improve with respect to the insurgency if the people see the government as responsible for the improved economic conditions (and improved satisfaction with life in general). This requirement calls for robust propaganda aimed at giving the government credit for any improvement in economic conditions, thereby increasing the population's satisfaction with life and insulating them from the insurgency.

Initial Support for the Insurgency

Changing the initial support for the insurgency has an effect similar to changing popular donation capability. The baseline model sets the popular support coefficient at 0.25, representing popular support for the GSPC from 25 percent of the population. Decreasing popular support prior to running the simulation also decreased the amount of money the GSPC gained through voluntary donations, leading the organization to resort to extortions sooner. This caused the organization's support to spiral downward, resulting in an early end to the GSPC as a viable entity. Conversely, increasing the level of support prior to simulation extended the GSPC's life. For example, if the GSPC's initial popular support level is set to .75, the organization actually increases in strength over time. Fortunately, the evidence indicates it is unlikely any Islamist insurgent group ever will enjoy much greater than 25 percent support among the Algerian populace.[\[81\]](#)

European Operations

Throughout the sensitivity analysis little changed with respect to European operations. Indeed, because Algerian and European operations appear somewhat independent, it is likely that if the Algerian GSPC is totally defeated, European elements of the organization will spin off on their own. In such an event, the European element of the GSPC would be able to collect and invest its excess funds rather than funnel them to Algeria. As this resource base increased, the model suggests authorities should expect a corresponding increase in the frequency and severity of terrorist operations in Europe.

Policy Options Analysis

To assess the impact of various governmental policy combinations, the authors manipulated various governmental controls in the model. These included the Algerian government's desires to control extortion, smuggling, business fronts, and operations as well as the level of European government control over terrorism. Additionally, the authors assessed how changes to the Maslow coefficient and external support affected simulation outcomes.

Algerian Government Controls

If the government of Algeria focuses its efforts on stopping GSPC extortion of its population, the results may backfire. If the government succeeds in stopping the GSPC from extorting the population, this has the unintended side effect of arresting the decline of GSPC support. Indeed, if the government is able to completely stop extortions, support among the populace for the GSPC actually starts increasing (albeit at an extremely gradual rate).

Instead of attempting to stop extortions, the Algerian government should focus its efforts on attempting to control smuggling. The government receives two benefits from this approach. First, since smuggling operations are the most lucrative fundraising source for the GSPC, cracking down on them forces a decline in GSPC operations against the government. Second, the GSPC's declining in revenue after the government crackdown forces the organization to maintain a high level of extortion operations. This, in turn, decreases popular support for the insurgency over time. A similar government crackdown against GSPC-affiliated businesses had less of an effect. Although simulation showed the government could decrease the GSPC's business front revenue by nearly 50 percent, this has a negligible effect on the larger system. Ultimately, GSPC revenue from legitimate business fronts is marginal compared to other sources of income. Thus, all else being equal, the government should apply its resources against more lucrative GSPC funding streams, the most lucrative being Sahel smuggling.

As an alternative to the policy of cracking down on GSPC fundraising methods, the Algerian government could crackdown on GSPC attacks against the government itself and its agents. In general, this policy appears more beneficial to the government than attacking GSPC sources of income. A simulated government crackdown on these kinds of GSPC operations decreased the number of attacks by half, with substantial benefits. After the government crackdown, support for the insurgency among the populace began to steadily decrease.

Maslow Coefficient

Governmental policies (or lack of policies) that increase or decrease the level of satisfaction felt by the population have a significant effect on the outcome of the insurgency. A satisfied populace will tend to view the government as legitimate, and, all else being equal, be less inclined to support the insurgency. Conversely, if popular disaffection increases over time, there is a corresponding increase in support for the insurgency. During simulation, this increase in support was self-reinforcing over time. As increased GSPC revenue from donations decreased pressure on the organization to extort from the population, its support level spiraled upward.

European Government Controls

The model gives simulated European governments a robust ability to control terrorist operations on their soil. If this control decreases (due to a decrease in either European capacity or will), the impact on the GSPC system is significant. Predictably, simulation shows that if European governments lessen their anti- and counter-terrorism efforts the number of terrorist attacks on European soil grows rapidly. Interestingly, however, simulation also suggests that as the GSPC's European cells find themselves more and more able to operate in Europe, they will send less and less money back to Algeria. In effect, if the Europeans allow the GSPC to operate under less pressure, the European GSPC is likely to schism (formally or informally) from its Algerian parent and create an independent organization.

External Support for the GSPC

The GSPC does not currently enjoy significant external support. Most of the worldwide supply of money supporting jihadist causes is flowing to support al Qaeda in Iraq (AQI). If the Iraqi situation is resolved somehow and the money previously flowing to support AQI becomes available to the GSPC, the consequences would be significant. An infusion of external support of only \$100 thousand per year is enough to allow the GSPC simultaneously to increase its operations against the Algerian government and decrease its fundraising efforts. These two immediate effects reverberate through the system, ultimately resulting in a gradual increase in the level of popular support for the insurgency. Thus, it is imperative policymakers do as much as possible to prevent the diversion of external support to the GSPC.

Conclusion

In developing the GSPC financial sub-system model, the authors capitalized on the advantages of systems dynamics modeling while remaining cognizant of the method's shortcomings. The first advantage of the system dynamics approach is that it provides the opportunity to perform robust quantitative analysis. Second, the systems dynamics approach allows examination of system performance over the entire course of a specified time period. The user is not limited to analyzing a single snapshot in time. Third, systems dynamics modeling allows for (and often depends on) the incorporation of expert opinions. Aggregating multiple and contradictory opinions on a system's performance improves the definition of system boundaries. Finally, modeling affords the analyst the ability to analyze multiple relationships among system variables, freeing the user from normal cognitive limitations.

Despite these methodological strengths, using a systems dynamics approach to characterize the GSPC financial sub-system presented three main challenges.^[82] First, the authors sought to create a model that could produce results policymakers could quickly and easily comprehend. The main vehicle for accomplishing this objective was the incorporation of a graphical user interface (GUI). The GUI provides a straightforward means of manipulating parameters, distancing the user (e.g., policymaker) from the inner workings of the model. Additionally, the interface provides pre-defined output graphs designed to display the most useful system behavior information using the smallest possible number of variables. Second, the authors had to avoid the tendency to over-generalize the model. This tendency usually results in a product applicable to a range of similar systems, but incapable of reflecting the nuances of the targeted system. While the approach used to develop the GSPC financial subsystem model may be valid for other terrorist organizations, the model itself is specific to the GSPC. Attempting to apply the model without modification to other terrorist organizations will yield invalid results. Finally, the authors had to avoid the tendency to model only portions of the system for which robust data existed. Disciplined reliance on expert opinion, diverse data sources, and parameter bounding techniques helped the authors overcome this proclivity.

Despite the authors' best efforts, the GSPC financial sub-system model has both strengths and weaknesses. Strengths include the model's level of complexity, stochastic functionality, and incorporation of delays. Weaknesses inherent in the model are its exclusive focus on the financial subsystem, limited data availability for building assumptions, and an incomplete modeling of system drivers.

While simplicity was the goal, as the model design process progressed it became evident that some level of complexity was necessary and beneficial. The complexity became necessary in order to accurately describe the numerous GSPC funding sources. Each point at which another component or financial source was incorporated into the model, the complexity increased proportionally. Nonetheless, the authors felt capturing these dynamics was important to ensure the model's fidelity. In the end, the level of complexity incorporated into the GSPC financing model enabled higher quality descriptive analysis despite limited data availability.

To offset the need for increased complexity, the authors constructed the GSPC finance model using a modular approach. Each GSPC fundraising technique has its own module, and all feed into a core stock. Additionally, support for insurgency, strategic operations, and European operations all reside in their own modules. This modularity provided enhanced flexibility and allowed the authors to make changes to individual components of the system throughout the project. This modularity also facilitated efficient sensitivity and policy options analyses.

In order to better replicate reality, wherever possible the model avoids the use of discrete numerical values and instead relies on stochastic inputs (e.g., distribution functions) to account for variable uncertainty. For example, the amount of money obtained from a fund-raising

operation is not always a fixed value. Using available open-source data and a degree of logical reasoning, model uses distribution functions to represent the spectrum of possible values for resource inputs and outputs.

In another attempt to make the model more realistic, the model incorporates a number of timing delays. Evaluations of system dynamic modeling within the social sciences commonly include the critique that models lack adequate consideration of the inherent delays in the targeted systems. Indeed, the impact from certain variable and/or feedback loops is seldom immediate. For example, although atrocities against civilians will decrease public support over time, the result is not immediate. Similarly, once an organization decides to undertake a fundraising activity, the inflow of funds takes some discrete amount of time. The GSPC financing model incorporates delay functionality in both of these cases, as well as several others where appropriate.

Despite these strengths, there are three significant shortcomings to the model. First, the model focuses exclusively on one subsystem among many that make up the composite GSPC system. While the authors contend the model has significant stand-alone value, its value would increase significantly with the addition of other subsystems. The most significant omission in the current model is the lack of consideration of organizational size. Incorporating recruitment, total membership, and attrition into the model would greatly enhance its value.

The second shortcoming is the lack of available data for assumption building. This shortcoming was imposed on the model due to the fact that the GSPC is not as well researched as other terrorist organizations. For example, the organizational structure and financial aspects of al Qaeda are extensively documented, producing a level of data well above that available on the GSPC. Data for this project came primarily from the academic literature, expert interviews, and open source reporting. These provided adequate insight into GSPC organizational size, objectives, and fundraising methods. Absent in the data were specifics on GSPC operating costs, operations expenditures, and specific amounts of money received from various fundraising operations. The authors had to infer the parameters for each of these variables through analysis. This analysis relied on information from expert interviews, data from other terrorist groups, theories of insurgent operations, polling data, and available economic statistics.

Finally, the model fails to account for a comprehensive list of system drivers. Numerous factors influence the level of popular support for insurgencies. A partial listing of these factors reveals the underlying complexity of this dynamic. Socioeconomic conditions, availability of public goods and services, level of dissatisfaction with current political structures, popular ability to participate in the political process, legitimacy of the government, and tactics used by the insurgent group all interact to determine the level of popular support for the regime and the rebellion. To prevent spiraling complexity, the present model incorporates a single user-adjustable variable to represent multiple system drivers and their combined effects. While this helps maintain simplicity and parsimony, it also significantly truncates the level of feedback within the system.

These various strengths and weaknesses of the GSPC financial subsystem model lead to three primary suggestions for future research. First, this project was confined to the financial aspects of the GSPC. Future efforts should incorporate other GSPC subsystems. Most importantly, organizational size has a significant impact on both the financial status and overall success of the GSPC. Evidence suggests direct ties between the GSPC's recruiting and finance functions. For example, the organization has been known to require new members to pay a fee to cover initial ascension costs.^[83] Additionally, as organizations grow, they incur additional overhead expenses and are capable of conducting an increased number of operations. Second, the authors recommend a social network analysis on the players within the GSPC system. While this would clearly characterize the overall system, it would also suggest how the organization moves its money internally. Most GSPC monetary transactions involve cash couriers. Thus, social network analysis would shed further light on the GSPC's fiscal structure, particularly with respect to how the organization disburses its funds for overhead and operational expenses. Third, the authors

recommend incorporating a more robust set of system drivers. This effort should follow the example set by Thomas, Kiser, Casebeer, and Bartolomei in their work on Sendero Luminoso.[\[84\]](#)

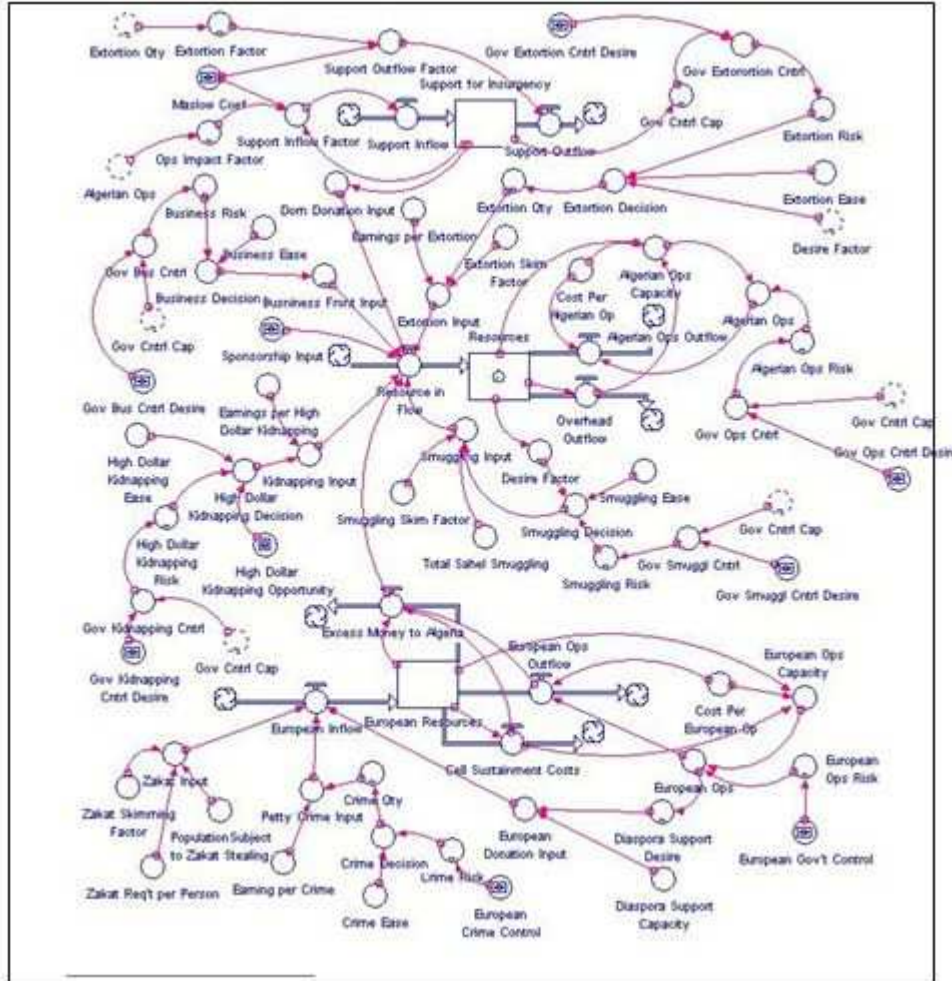
While the model developed during this project would benefit from these additional research efforts, it has already shown itself to have heuristic, descriptive, and even limited predictive capabilities. As such, the model has expanded current understanding of the GSPC financial sub-system and its impact on the broader organization. Most importantly, however, modeling results validate the systems dynamics approach as a means of studying terrorist organizations. Applying the approach to other organizations or other aspects of terrorism research is likely to yield significant dividends.

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Appendix: Screen Capture of Model from STELLA®



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63. Matthew Levitt, *Hamas: Politics, Charity, and Terrorism in the Service of Jihad* (New Haven: Yale University Press in cooperation with the Washington Institute for Near East Policy, 2006), 55.
64. Carol Migdalovitz, *Op. Cit.*, 2. Of these countries, Italy and Spain suffer the highest levels of GSPC activity. Some experts assess that Italy has become a forward logistical base for operational activities throughout Europe, and the group has declared France its primary European target. Kathryn Haahr-escolano, "[GSPC in Italy: The Forward Base of Jihad in Europe](#)," *The Jamestown Foundation, Terrorism Monitor* 4, No. 3 (February 9, 2006), 2-3.
65. London-based Algerian Haydar Abd Doha was critical to this effort. Keats, *Op. Cit.*, "[In the Spotlight: The Salafist Group for Call and Combat](#)," *Center for Defense Information, CDI.org*, January 13, 2003 (updated.)
66. Jonathan Schanzer, "[Algeria's GSPC and America's 'War on Terror'](#)," *Op. Cit.*
67. Reuters, "Swiss Police Thwart Plane Bomb Plot," June 9, 2006.
68. Sifaoui, *Op. Cit.*, 112-114.
69. Keats, "[In the Spotlight: The Salafist Group for Call and Combat](#)," *Op. Cit.*
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72. For an example of how a GSPC cell allocates its resources, see Reuters, "Ten Islamic Militants Jailed over French Bomb Plot," December 16, 2004. As this report notes, the ten-member GSPC cell that planned a foiled Christmas 2000 attack on a market in Strasbourg self-financed both overhead and operations costs through petty crime, including credit card fraud.
73. See Sifaoui, *Op. Cit.*, 26-30, for a discussion of one European fundraising cell's devotion to the Algerian GSPC cause. Ulph, *Op. Cit.*, 2, also alleged some monies flow to support other causes, such as Algerians in Afghanistan.
74. William B. Quandt, "Algeria's Uneasy Peace," *Journal of Democracy* 13, No. 4 (October 2002), 18 and 22.
75. Authors' interview with GSPC field researcher, May 25, 2006.

76. Various open sources attribute eight European terrorist plots to the GSPC from 1999 to 2006: the Paris-Dakur Rally, the Strasbourg market plot, the U.S. Embassy in Paris and Rome, the G-8 summit, an attack in Milan against an unidentified target, the Spanish National Court, and an El Al Airliner. Additionally, the millennium plot against Los Angeles International Airport is attributed to the GSPC.

77. Agence France-Presse , "Libya Paid Five Million Euro Ransom for Sahara Hostages: Diplomats," *Clari News*, Special Edition, Online Article, August 21, 2003.

78. FBIS report, "Algerian Report Traces Career of Terrorist Leader Abderrazeak the Para."

79. *Ibid.* This report provides a fascinatingly detailed account of how Para spend the ransom money, complete with the names of purchases, amount spent, and exact type and amount of each weapon purchased.

80. Gilbert and Troitzsch, *Op. Cit.*, 24.

81. Quandt, *Op. Cit.*, 16-18.

82. The shortcomings of systems dynamics modeling covered in the next three paragraphs are derived from Thomas, Kiser, and Casebeer, *Op. Cit.*, 14.

83. FBIS report, "Morocco Arrests More Terrorism Suspects Said Belonging to 'Tangier Cell,'" GMP2006013171002, *Rabat Al-Alam*, January 31, 2006. Report by Abdelkamil El-Isaoui, "New Elements Belonging to Tangier Cell Arrested."

84. See Thomas, Kiser, and Casebeer, *Warlords Rising: Confronting Violent Non-State Actors*, *Op. Cit.*; and Bartolomei, Casebeer, and Thomas, "Modeling Violent Non-State Actors: A Summary of Concepts and Methods," *Op. Cit.*